

Why Build Stellar Interferometers?

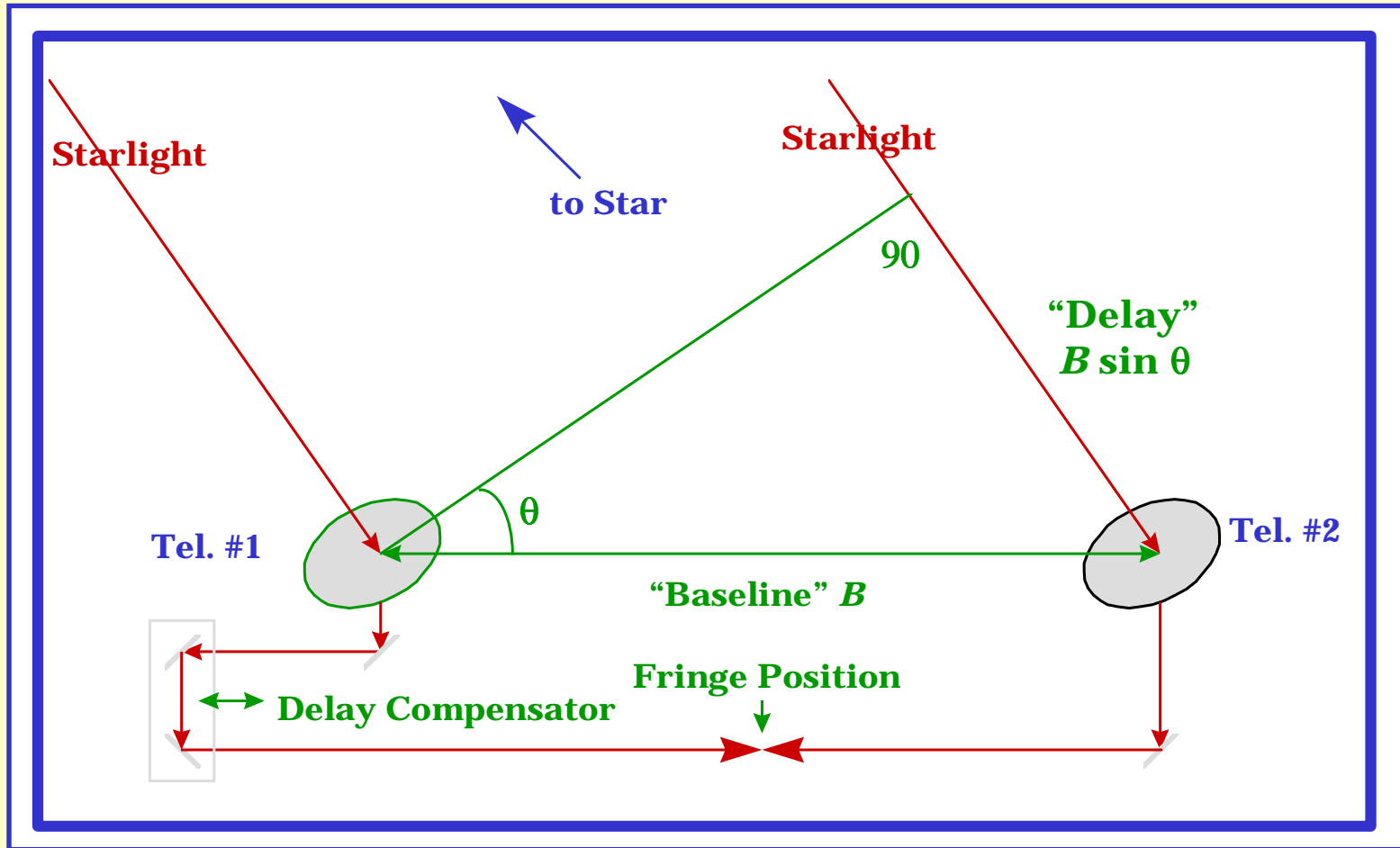
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Because they are there!?

Technical Challenge
&
Scientific Opportunity



“Simple” Long-Baseline Interferometer

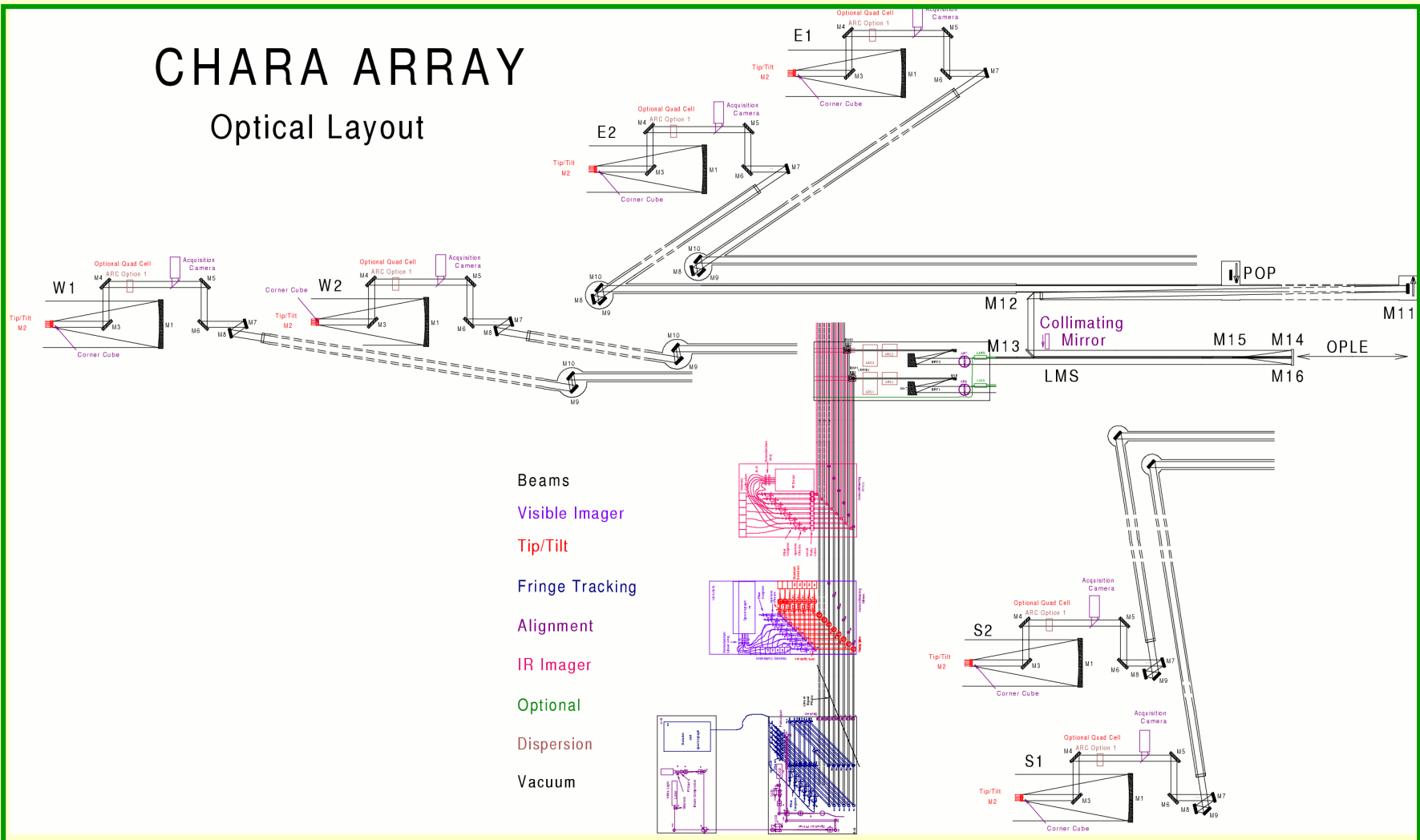


The Real Thing

Could Throughput be an Issue Here?

CHARA ARRAY

Optical Layout



This is a Tough Business



*Pease's 50-ft Interferometer on
Mt. Wilson, c. 1935*

*50-ft Interferometer site
in early 1980's*



Currently Operating Instruments

Name	Institution	Site	Number of Elements	Element Aperture (cm)	Max. Baseline (m)	Operating Wavelength (microns)	Operating Status
GI2T	CERGA	Calern	2	150	35	0.4 - 0.8 & >1.2	since 1985
COAST	Cambridge U	Cambridge	4	40	100	0.4 - 0.95 & 2.2	since 1991
SUSI	Sydney U	Narrabri	13	14	640	0.4 - 0.66	since 1991
IOTA	CfA	Mt. Hopkins	3	45	38	0.5 - 2.2	since 1993
ISI	Berkeley U	Mt. Wilson	3	165	30(+)	10	since 1990
NPOI	USNO/NRL	Anderson Mesa	6	60	435	0.45 - 0.85	since 1995
PTI	JPL/Caltech	Mt. Palomar	2	40	110	1.5 - 2.4	since 1995
CHARA	Georgia St. U	Mt. Wilson	6	100	350	0.45 - 2.4	since 1999
Keck	CARA	Mauna Kea	2(4)	1,000(150)	165	2.2 - 10	fringes 03/01
VLTI	ESO	Cerro Paranal	4(3)	840(250)	200	0.45-12	fringes 03/01

Challenges

- Interferometers are Complex & Hierarchical Systems

Numerous sophisticated subsystems:

Siderostats/Telescopes

Delay Lines

Fringe Trackers

Beam Combiners

Alignment

Metrology (Astrometry requires exceptional performance)

All working together!

Attention to calibration is crucial

Lots of Cool Hardware!



24 June 2002

Michelson Summer School

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Challenges (Cont.)

- New Tools & Algorithms Required

Scheduling & Archiving

Imaging – How do we combine many beams simultaneously?

- Science

What is optimal? Realistic?

Avoid over-heightening expectations

Get theorists involved

Develop collaborations

- Funding

Still regarded as a developmental area providing niche science (Lots of stars, not much galaxy stuff!)

Patience & perseverance

Develop Partnerships

Opportunities

- Wonderful Resolution
 - 1,000 mas - classical imaging*
 - 20 mas - adaptive optics*
 - 10 mas - HST*
 - 0.1 mas - SUSI*
 - 2 orders gain over AO & HST*
 - (but very narrow FOV!)*
- Access to New Science
 - Resolution and Accuracy*

Opportunities (Cont.)

Current Projects are Stepping Stones to an OVLA

- Prerequisites
 - Significant science must be forthcoming (Soon!)*
 - Imaging must be demonstrated for complex objects*
 - Partnerships must be established*
 - More black-belt interferometrists needed*
- May be built in the 2010 decade??
 - If so, those in this room will be building it*
- Learn from the radio experience
 - $T_{VLA} - T_{GBI} = \text{Only } \sim 20 \text{ years!}$
 - But, is O/IR interferometry really analogous?*

Interferometry Science

Most Favorable Areas

- Single Stars
 - Effective Temperatures & Fluxes
 - Young Stars' Structure & Morphology
 - Stellar Surface Features
 - Novae/Supernovae
- Binary & Multiple Stars
 - Resolved Spectroscopic Binaries
 - Stellar Masses and Luminosities*
 - Distance Calibrations*
 - Radii of Components*
 - Detection of Low-Mass Companions
- Astrometry
 - Ground (NPOI) & Space (SIM)

Nice Example of a Revolution

Resolved Spectroscopic Binaries

- Double-Lined Binaries
Spectroscopy gives mass ratio & $a \sin i$
Interferometry gives a and i
Together yield masses & distances
(“*orbital parallax*”)
~200 DSB’s have $a'' > 1$ mas
- Single-Lined Binaries
Accurate parallaxes give individual masses
- 70% of SB’s are Resolvable
Many radii also measurable

Interferometry Science

Other Areas

- Single Stars

- Limb Darkening
- Linear Diameters
- Star Formation Phenomena & Dynamics
- Pre-Main Sequence Objects
- Absolute Rotation
- Flare Star Phenomena
- Cepheid P-L Calibration
- Mira Pulsations
- Non-radial Oscillations
- Hot Star Phenomena (shells, winds, etc.)
- Cool Star Shells

- Binary & Multiple Stars

- Duplicity Surveys
- Close Binary Phenomena

- Star Clusters

- Proper Motions
- Duplicity Surveys

- Extragalactic

- Binaries in Magellanic Clouds
- AGN Structure

- Solar System

- Planetary Satellites
- Minor Planets & Comets
- Solar Surface

- Extrasolar Planets

- Astrometric Detection
- Inspection/Verification
- Imaging exo-zodiacal dust
- Imaging protoplanetary disks

Interferometry Science

Other Areas (Cont.)

- You'll Think of Something

(Get the theorists involved!)

“History has taught us that whenever a new technique enters a new realm of observational phase space, the most striking and productive results tend to be those not anticipated by even the most prescient thinkers”

- Daniel Popper, 1990

Interferometry Science

In Perspective

- Presently Sensitivity & (U,V) Limited
Low Throughput is Inevitable
Adaptive Optics May Help
Limited Imaging Capability
- Outstanding Stellar Science
- Limited Extragalactic Science
Limited by Sensitivity & Resolution